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ABSTRACT

This unit of instruction was designed as a basic course involving the study of light, sound, and heat at the junior high school level. The booklet lists the relevant state-adopted texts and states the performance objectives for the unit. It provides an outline of the course content and suggests experiments, demonstrations, field trips, and topics for student projects, reports, discussions, and other activities. Also listed are related mathematics problems, and relevant films available from the Dade County Audiovisual Center. Reference books are recommended, and a master sheet is provided relating each suggested activity to the specific performance objectives. (JR)

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AUTHORIZED COURSE OF INSTRUCTION FOR THE QUINMESTER PROGRAM

ENERGY: LIGHT, SOUND, AND HEAT

5311.04
5312.04
5313.04

SCIENCE
(Experimental)

DADE COUNTY PUBLIC SCHOOLS

DIVISION OF INSTRUCTION • 1971

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Written by June P. Castaldi
for the
DIVISION OF INSTRUCTION
Dade County Public Schools
Miami, Fla.
1971

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ENERGY: LIGHT, SOUND, AND HEAT

COURSE DESCRIPTION:

A basic course involving the study of light, sound, and heat at the junior high level.

ENROLLMENT GUIDELINES:

None

STATE ADOPTED TEXTS:

1. Abraham, Norman et al. Interaction of Matter and Energy. Chicago: Rand McNally and Co., 1968.
2. Brandwein, Paul F. et al. Energy Its Forms and Changes. New York: Harcourt, Brace and World, Inc., 1968.
3. Intermediate Science Curriculum Study. Probing The Natural World Vols. 1, 2A, 3B. Morristown, N. J.: Silver Burdett, 1970.
4. Marean, John A. and Ledbetter, Elaine W. Investigating Matter and Energy. Menlo Park, California: Addison-Wesley Publishing Co., 1968.
5. Oxenhorn, Joseph. Pathways in Science - Physics 3. New York: Globe Book Co, 1970.
6. Thurber, Walter, and Kilburn, Robert. Exploring Physical Science. Boston: Allyn and Bacon, Inc., 1966.

PERFORMANCE OBJECTIVES

The student will:

1. Given laboratory experiences, measure the temperature of a substance using more than one kind of temperature scale.

2. Describe the difference between temperature and heat by citing examples.

3. Discover how heat affects various states of matter.

4. Compare various temperature scales.

5. Perform laboratory experiments that enable him to make accurate predictions based on the principle of heat transfer.

6. Based on experiences with sound, describe how various sounds are produced, transmitted, and detected.

7. List the factors that must be considered when sound-proofing a building or room.

8. Given practical experience, distinguish between music and noise.

9. Perform experiments enabling him to discover how his ear functions.

10. Given laboratory experiences with light, relate the theoretical structure of a light wave to the behavior of light.

11. Using prisms and light mixing machines, associate the composition of white light with the color spectrum.

12. Given a diagram of the eye, illustrate the path of light rays into the eye.

13. Given a series of laboratory experiences with mirrors, apply the law of reflection to functional instruments man has developed.

14. Based on experiences with lenses, construct diagrams showing how lenses form images.

COURSE OUTLINE

I. Heat Energy

A. The nature of heat

1. Heat and the motion of molecules
2. Sources of heat
3. Temperature

B. Measuring Temperature

1. Types of thermometers
2. Temperature scales

C. Expansion of matter when heated

1. Behavior of solids
2. Behavior of liquids
3. Behavior of gases
4. Practical applications

D. Methods of heat transfer

1. Conduction
2. Convections
3. Radiation
4. Practical applications

E. Measuring heat

1. BTU
2. Calorie

II. Sound Energy

A. The nature of sound

1. Production of sound
2. Transmission of sound
   a) Structure and characteristics of a sound wave
   b) Speed of sound through different mediums
3. Ultrasonics
4. Supersonics
   a) The sound barrier
   b) The sonic boom

B. How the body hears vibrations

1. Structure of the ear
2. The process of hearing

C. How the body makes vibrations

1. Structures involved
2. The process of speech

D. Acoustics

1. Reflection, absorption, refraction of sound
2. Practical applications

E. Noise vs. music

1. What distinguishes noise from music?
2. Characteristics of musical tones and instruments
3. Quality of sound

F. Reinforcement of sound

1. Resonance
2. Vibrations

III. Light Energy

A. The Nature of light

1. Theories concerning structure of light waves
2. Principle source of light
3. Behavior of light
4. Polarization
5. Relationship of heat and light
   a) Incandescence
   b) Fluorescence
   c) Phosphorescence

B. Electromagnetic waves

1. The electromagnetic spectrum
2. Visible light
   a) White light
   b) The spectrum and color

C. How and why our eyes see color

1. Structure of the eye
2. Visual perception

D. Reflection

1. Law of reflection
2. Images in plane and curved mirrors
3. Applications

E. Refraction

1. Law of refraction
2. Lenses and images formed
3. Optical instruments

EXPERIMENTS AND/OR DEMONSTRATIONS

(This section has been incorporated into one because all the items listed can be performed as student experiments. However, your ability to have the entire class perform the same experiment at the same time depends largely on the amount of equipment available at your school.)

Davis, Ira; Burnett, John; Gross, E.; Pritchard, L. Science 1 - Observation and Experiment. New York: Holt, Rinehart, and Winston, 1965.

1. Sources of light (p. 142)
2. Why does burning fuel give light? (p. 144)
3. How is light made with electricity? (p. 146)
4. Reflection (pp. 149-151)
5. Double reflection (p. 152)
6. Reflection from a concave surface (p. 152)
7. How does light travel? (p. 157)
8. Lenses (p. 161)
9. Refraction (p. 163)
10. Why is a lens in a camera? (p. 164)
11. The eye (p. 165)
12. Magnification (p. 166)
13. Prisms and white light (p. 167)
14. What happens when colored lights mix? (p. 170)
15. Sound production (pp. 178-181)
16. The body produces sound (p. 181)
17. Hearing sounds (p. 183)
18. Transmission of sound (p. 185)
19. Does sound travel through a vacuum? (p. 185)
20. Speed of sound (p. 188)
21. Control of sound (p. 189)
22. Echoes (p. 192)
23. Pleasing sounds (p. 195)
24. Noise vs. pleasing sounds (p. 196)
25. Resonance (p. 197)
26. How does the length of wire effect pitch? (p. 201)
27. Pitch (p. 199)
28. Amplification of sound (p. 203)
29. How do holes control the length of air in a column? (p. 205)
30. Producing sound in reed instruments (p. 206)

Strumeyer, James and Harris, Dennis. Exercises and Investigations for Science 1. New York: Holt, Rinehart and Winston, 1965.

31. The convex lens (Inv. 5A p. 47)

32. Applications of the convex lens (Inv. 5B p. 49)
33. Sound waves in a vacuum (Inv. 6A p. 55)
34. Speed of sound in matter (Inv. 6B p. 57)

Davis, Ira; Burnett, John; Gross, E.; Johnson, T. Science 3 - Discovery and Progress. New York: Holt, Rinehart, and Winston, 1965.

35. Heat and matter (p. 75)
36. What affect does friction have on matter? (p. 75)
37. How is heat energy transferred? (p. 77)
38. Temperature (p. 78)
39. How are expansion, contraction, and temperature related? (p. 79)
40. To what degree do metals expand when heated? (p. 80)
41. Thermometers (p. 82)
42. Is there a difference between temperature and quantity of heat? (p.83)
43. Heat transfer (p. 85)
44. Radiant heat (p. 86)
45. Are liquids poor conductors of heat? (p. 87)
46. How is heat transferred in water? (p. 88)
47. What is the caloric value of fuel? (p. 90)
48. What are some ways to produce sounds? (p. 266)
49. Can sound travel is a vacuum? (p. 269)
50. Sound conduction (p. 270)
51. The ear and sound (p. 273)
52. Test your hearing (p. 273)
53. What determines the pitch in a stringed instrument? (p. 276)
54. How do air columns produce sound? (p. 278)
55. What are chords? (p. 280)
56. How does light travel? (p. 292)
57. How are shadows formed? (p. 293)
58. What causes a reflection? (p. 295)
59. Mirror images (p. 295)
60. Law of reflection (p. 296)
61. What is refraction? (p. 299)
62. How does a lens focus light? (p. 300)
63. Finding the focal point of a lens (p. 300)
64. Principle of the telescope (p. 302)
65. What is white light? (p. 304)
66. The pinhole camera (p. 307)
67. Pupil reaction to light (p. 310)
68. Accommodation of the eye (p. 311)
69. What happens to the brightness of light as the distance from the light is increased? (p. 315)

Strumeyer, Joseph and Harris, Dennis. Exercises and Investigations for Science Discovery and Progress. New York: Holt, Rinehart, and Winston, 1965.

70. The Energy of heat (Inv. 4A p. 31)
71. Heat capacity and substances (Inv. 4B p. 33)
72. Properties of sound (Inv. 11A p. 93)
73. Interpreting data on sound (Inv. 11B p. 95)

74. Light rays and the plane mirror (Inv. 12A p. 101)
75. Applications of plane mirrors (Inv. 12B p. 105)
76. Concave mirrors (Inv. 13A p. 111)
77. Applications of concave mirrors (Inv. 13B p. 115)

Thurber, Walter and Kilburn, Robert. Exploring Physical Science. Boston: Allyn and Bacon, Inc., 1966.

78. Sound transmission (p. 178)
79. Sound energy (p. 179)
80. Sound waves (p. 180)
81. Detecting waves (p. 181)
82. Shock waves (p. 182)
83. Speed of sound (p. 184)
84. Echoes (p. 185)
85. Differences in sound waves (p. 189)
86. Vibrations (p. 190)
87. Sounding boards (p. 192)
88. String length and frequency (p. 193)
89. Vibrations (p. 190)
90. Effect of string size (p. 194)
91. Resonance (p. 198)
92. Wind instruments (p. 199)
93. Sound waves (#1 p. 204)
94. Resonance (#2, 3, 4 p. 204)
95. Sound transmission (#6 p. 204)
96. Speed of sound (#8 p. 204)
97. Oscilloscope (#9 p. 205)
98. Measuring distance between compressions (#10 p. 205)
99. Absorption of sound (#11 p. 205)
100. Light intensity (p. 211)
101. Shadows (p. 212)
102. Pinhole viewer (p. 214)
103. Reflections (pp. 215-17)
104. Locating an image (p. 218)
105. Concave-convex reflections (pp. 222-23)
106. Refraction (pp. 225-26)
107. Color (p. 228)
108. Lens images (pp. 229-235)
109. Index of Refraction (#3 p. 236)
110. Candle power (#6 p. 236)
111. Reflection (#8, 11 p. 236)
112. Refraction (#10 p. 236)
113. Heat capacity of various substances (pp. 296-98)
114. Behavior and Expansion of water (#2, 5, 6 p. 300)
115. Temperature regions in a flame (p. 300 #7)
116. Comparison of heating rates of water (#9 p. 300)

Oxenhorn, Joseph, Pathways in Science-Physics 3. New York: Globe Book Co., 1970.

117. How are sounds made? (pp. 23-24)
118. Is air needed to carry sound vibration? (p. 29)

119. Materials that carry sound (p. 30)
120. Home-made vocal cords (p. 41)
121. How is pitch changed? (p. 47)
122. Making sounds louder (p. 50)
123. How does tone get quality? (p. 55)
124. What is resonance? (p. 57)
125. Making a string instrument (p. 63)
126. Making a wind instrument (p. 64)
127. How does a phonograph record work? (p. 71)
128. What happens when light strikes an object? (p. 90)
129. How are shadows formed? (p. 92)
130. Can light bend? (p. 95)
131. Making a magic camera (p. 97)
132. What do we see in the dark? (p. 104)
133. What is the job of the pupil? (p. 104)
134. Focusing in the human eye (p. 105)
135. Colorblindness (p. 105)
136. How long does an image stay on the retina? (p. 108)
137. Optical illusions (p. 107)
138. Reflection (making a mirror) (p. 112)
139. Kinds of reflection (p. 113)
140. Images formed by plane mirrors (p. 114)
141. Law of reflection (p. 115)
142. What kinds of images are formed by curved surfaces? (p. 118)
143. Making a periscope (p. 122)
144. Refraction (p. 127)
145. Paths of light through lenses (p. 128)
146. How does an opaque object get its color? (p. 142)

Suggestion: Have your school invest in Exploring Physical Science Record Book. This is a lab manual published by Allyn and Bacon, 1970, to correspond with the text of the same title. The labs can be adapted easily to your particular situation regardless of what text you use.

PROJECTS AND ACTIVITIES

1. Have students bring several different kinds of wire. Cut each in lengths of about 12 inches. Mount them on a board. Pluck the strings. Compare and explain the differences in the sounds.

2. A student may train his dog to answer to a dog whistle. Let him bring the dog to class to demonstrate.

3. Arrange to have a few students who each play a different musical instrument come to class to play. Explain about the instruments, scales, pitch, harmony, etc.

4. Build a simple xylophone.

5. Play various records at the wrong speeds. Explain what is happening to the sound.

6. Put on a shadow show for the class by making different figures on mounted sticks. Have the class try to guess what they represent.

7. Mount and display a collection of lenses from old cameras and eyeglasses.

8. Build a color wheel of primary light colors and demonstrate to the class the effect of mixing colored light.

9. Demonstrate the effect of mixing colored pigments.

10. Take pictures with infra red film and compare the results with ordinary film.

11. Build a crystal radio set.

12. Make an air thermometer.

13. Make your own telescope.

14. Obtain an old bi-metallic strip thermostat. Use the strip and contact as a switch. Attach a flashlight bulb in series with a flashlight battery. Try to adjust the strip so that it is sensitive to the heat from a match.

15. Refrigerate an equal weight of oil, water, and alcohol for several hours. Measure the time required for them to return to room temperature.

16. Demonstrate some effects of polarized light.

17. Use an oscilloscope to demonstrate different wave patterns to the class. Show frequency and amplitude.

18. Make voice and music recordings with a tape recorder. Compare the quality of sound reproduced by various tape speeds.

REPORTS

1. Ancient drums.
2. The work of the New York Eye Bank.
3. How an x-ray machine works. Include x-ray pictures.
4. The hearing of different animals.
5. Any one of the following scientists:

Isaac Newton	Niels Bohr
William Herschel	Guglielmo Marconi
Albert Michelson	William Roentgen
Albert Einstein	

6. The Solar Battery ... include structure, how it works, and its use in space vehicles.
7. The careers of Heat Engineering and Air Conditioning.
8. The invisible radiations around us.
9. The invention of the telescope, microscope, and periscope.
10. Sonar and the fathometer.
11. The field of optics.
12. The methods used in the production of dry ice and liquid air.
13. How a radiometer works.
14. How phonograph records are produced and reproduced.
15. Mirages, include diagrams.

FIELD TRIPS

1. The A. V. department of your school. Have the teacher explain about tape recorders, projectors, etc.
2. A radio station.
3. A television station.
4. A paint and dye plant.
5. A photography lab.
6. Visit an optometrist and have him explain the grinding of lenses to fit prescriptions.

RELATED MATH PROBLEMS

Temperature Conversions Scales:

$C = 5/9\ (F - 32)$
$F = 9/5\ C + 32$
$K = C + 273$
$R = F + 459.7$

1. What temperature on the Celcius scale is equivalent to 250° F.?
2. What is the equivalent temperature on the Kelvin scale?
3. Change 30° C to F
4. Change -25° F to C and then to K
5. Change 98.6° F to C
6. On a day when the temperature changes from 20° F. to 45° F., how many degrees would a Celcius thermometer change?

Intensity of Illumination Formula:

$$\text{Foot-candles} = \frac{\text{candlepower}}{(\text{distance in feet})^2} \quad \text{or} \quad fc = \frac{cp}{ft^2}$$

7. What is the intensity of illumination, in foot-candles, 5 feet from a 100 candlepower lamp?
8. An unknown lamp placed 0.3 m from the screen of a Bunsen photometer produces the same intensity as a 100-cp lamp placed at a distance of 0.2 m from the screen. What is the candlepower of the unknown lamp?
9. At what distance will a 75-cp lamp provide 3-fc of illumination?

Object size and image size relationship formula:

$$\frac{\text{Size of image}}{\text{Size of object}} = \frac{\text{distance of image}}{\text{distance of object}}$$

10. An object 8 inches long is located 3 feet from a concave mirror. Its image is $1\frac{1}{2}$ feet in front of the mirror. What is the length of the image?

FILMS AVAILABLE FROM DADE COUNTY AUDIOVISUAL CENTER

Films have been listed according to topic

HEAT

1. Heat and Its Behavior
   AV#1-01875, 11 minutes, BW
2. Heat Conduction
   AV#1-01979, 10 minutes, BW
3. Heat Convection and Radiation
   AV#1-01878, 10 minutes, C
4. Heat: Its Nature and Transfer
   AV#1-01874, 11 minutes, BW
5. Learning About Heat
   AV#1-01867, 8 minutes, BW
6. The Nature of Heat
   AV#1-01869, 10 minutes, BW

SOUND

7. Ears and Hearing
   AV#1-03067, 10 minutes, BW
8. Ears: Structure and Care
   AV#1-03071, 11 minutes, BW
9. Hearing the Orchestra: Science in the Orchestra (Part 1)
   AV#1-11717, 13 minutes, BW
10. How the Ear Functions
    AV#1-03076, 11 minutes, BW
11. Sound
    AV#1-01839, 10 minutes, BW
12. Sound
    AV#1-01837, 10 minutes, BW
13. Sounds in the Sea
    AV#1-11178, 14 minutes, C
14. Sound Waves and Their Sources
    AV#1-01840, 11 minutes, BW
15. Learning About Sound
    AV#1-01834, 8 minutes, BW

LIGHT

16. Blind As a Bat
    AV#1-03026, 7 minutes, C
17. Exploring Electromagnetic Energy
    AV#1-10757, 14 minutes, C
18. Eyes and Their Care
    AV#1-03141, 11 minutes, BW
19. Eyes: Their Structure and Function
    AV#1-03513, 11 minutes, C
20. How the Eye Functions
    AV#1-03148, 11 minutes, BW

21. Learning About Light
AV#1-01848, 9 minutes, BW
22. The Science of Light
AV#1-03160, 11 minutes, C
23. Light and Its Story
AV#1-10737, 13½ minutes, C
24. Light and Shadow
AV#1-01856, 10 minutes, BW
25. Light Refraction
AV#1-10730, 14 minutes, BW
26. Light Sensitive Materials
AV#1-13061, 22 minutes, C
27. Elementary Optics in Photography
AV#1-11698, 19 minutes, BW
28. Light Waves and Their Uses
AV#1-01851, 11 minutes, BW
29. Cosmic Rays
AV#1-30330, 29 minutes, C
30. Demonstrations With Light
AV#1-10728, 11 minutes, C
31. Discovering Color
AV#1-11682, 15 minutes, C

SUGGESTED DISCUSSION QUESTIONS

1. How does a stethoscope help a doctor?
2. What problems arise with regard to sound in designing auditoriums? How are they solved?
3. How can you demonstrate that light can do work?
4. How can you demonstrate that light travels in a straight line while sound can be heard around corners? How could you make light travel around a corner?
5. Is it easier for light or heat radiations to go through glass? How do people who want to grow plants indoors make use of this fact?
6. How could you use your knowledge of the speed of light and sound to determine the distance of a far-off thunderstorm?
7. How do doctors make use of the ultra-violet and infrared radiations?
8. What is the difference between heat and temperature?
9. Assume the numerals on a thermometer were worn off. How would you know where to write them?
10. Why do substances expand and contract when cooled?
11. What provisions are made for the expansion of bridges? of railroad tracks? of paved highways?
12. How is heat transferred from the hot end of a metal rod to the cold end. Explain fully.
13. The coldest days of winter usually occur several weeks after the shortest day of the year. Explain.

REFERENCES

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2. Brandwein, P. et al. The World of Matter and Energy. New York: Harcourt, Brace and World, 1964.

3. Davis, Ira et al. Science 1 - Observation and Experiment. New York: Holt, Rinehart, and Winston, 1965.

4. Davis, Ira et al. Science 3 - Experiment and Discovery. New York: Holt, Rinehart, and Winston, 1965.

5. Davis, Ira et al. Science Discovery and Progress. New York: Holt, Rinehart, and Winston, 1965.

6. Oxenhorn, Joseph. Pathways in Science - Physics 3. New York: Globe Book Co., 1970.

7. Strumeyer, Joseph and Harris, Dennis. Exercises and Investigations for Science Book 1. New York: Holt, Rinehart, Winston, 1965.

8. Strumeyer, Joseph and Harris, Dennis. Exercises and Investigations for Science Discovery and Progress. New York: Holt, Rinehart, and Winston, 1965.

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10. Tracy, G.; Tropp, H.; Friedl, A. Modern Physical Science. New York: Holt, Rinehart, Winston, 1970.

11. Weisler, Jules. Review Text in Physical Science-Intermediate Level. New York: Amsco School Publications, 1970.

MASTER SHEET - ENERGY: LIGHT, SOUND, AND HEAT

Objectives	Demonstrations/ Experiments	Activities/ Projects	Reports	Field Trips	Math Problems	Films	Discussion Questions
1	35, 38, 41	1				1, 5, 6	
2	35,36,39,40,42,47, 115	14, 15	7			1, 5, 6	8
3	35,39,45,70,71,113, 114,116	14	6, 12			4	5,13,11,10
4	38, 41	12			1, 2, 3, 4, 5, 6	1,4,5,6	9
5	37,43,44,46	14, 15	13			3, 4	10, 7, 12
6	15,16,17,18,19,20, 33,34,50,72,78,79, 80,81,82,96,117, 118,119,120,121	1,2,11,17	1,10,14	1, 2		11,12,13, 14,15	1, 6
7	22,73,83,84,85,98, 99					11,12,14,15	2
8	23,24,25,26,27,28, 29,30,53,54,55,86, 87,88,89,90,91,92, 94,97,122,123,124, 125,126,127	3,4,5,16,17, 18	14	1,2,3		9	
9	17, 51, 52	2	4			8,7,10	1
10	1,2,3,7,56,57,69, 100,101,128,129, 130,146	6,10,16	3,5,8			17,21,22, 23,24,28,29	3,4,5,6,7
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